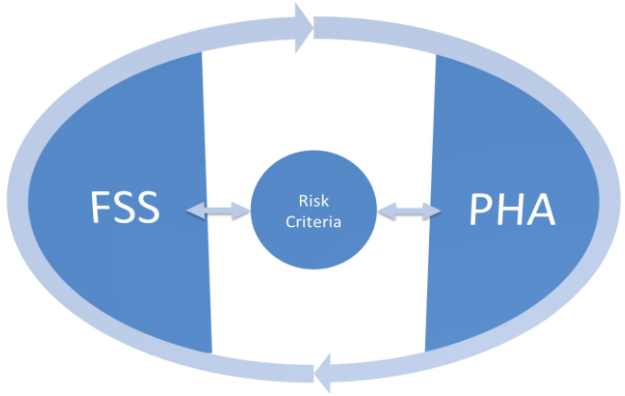
MARY KAY O'CONNOR PROCESS SAFETY CENTER
TEXAS A&M ENGINEERING EXPERIMENT STATION

AcuTech PROCESS RISK MANAGEMENT

Integrating the PHA and FSS into a Site Risk Assessment Life Cycle



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Authors

Colin D Armstrong | Senior Engineer

- Technical Lead for numerous FSS and QRA projects in oil, gas, LNG, and specialty chemical industries worldwide
- Experienced in all aspects of QRA, consequence modeling, frequency assessment, scenario analysis (FTA, FMEA, event tree, LOPA, etc.)
- Instructor of QRA and Consequence Modeling for operating companies and students at University of Maryland
- Investigator and expert witness in response to incidents and OSHA citations

Sam Aigen, CCPSC | Senior Engineer

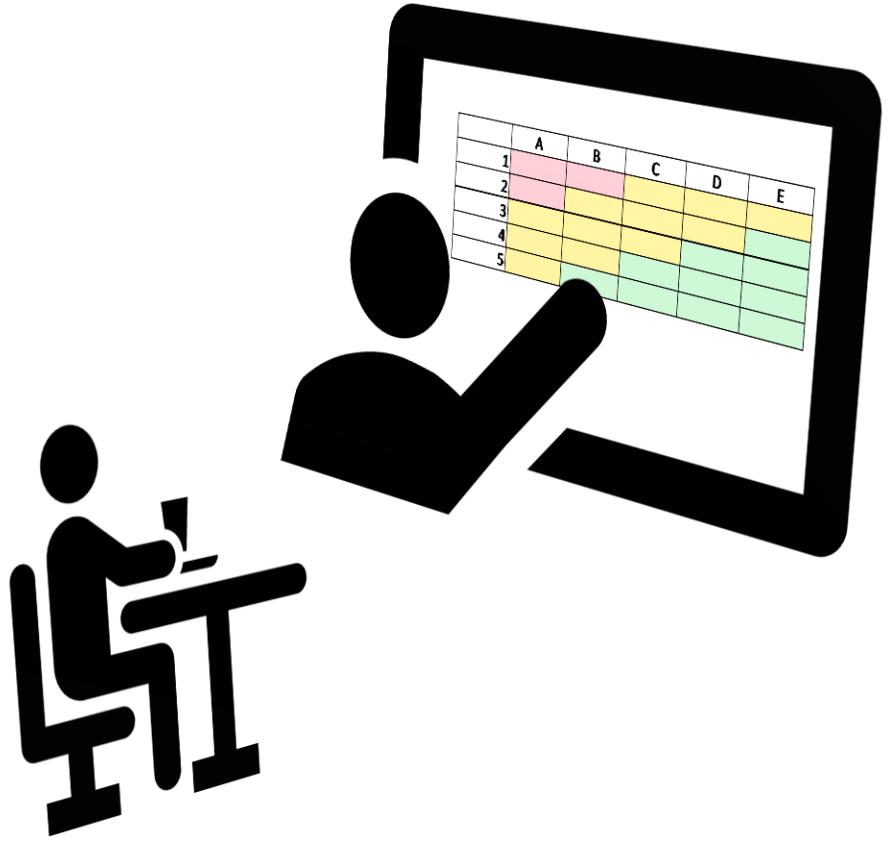
- 12 years of experience
- 6 years with ExxonMobil
  - Utilities, Heat Transfer
  - Distillation
  - Hydroprocessing
- 6 years with AcuTech
  - Hundreds of PHAs
  - PSM/RMP/CalARP Audits
  - QRA/ Facility Siting Study
  - PSM Program Development
  - Terminal Supply and Logistics Modeling

Agenda

- Elements of Process Hazard Analysis (PHA)
- Elements of Risk-Based Facility Siting Study (FSS)
- PHA/FSS Overlap
- How a PHA Feeds to FSS
- How a FSS Feeds to PHA
- Information Flow Between the Studies
- Aligning Studies through Risk Criteria
- Q&A

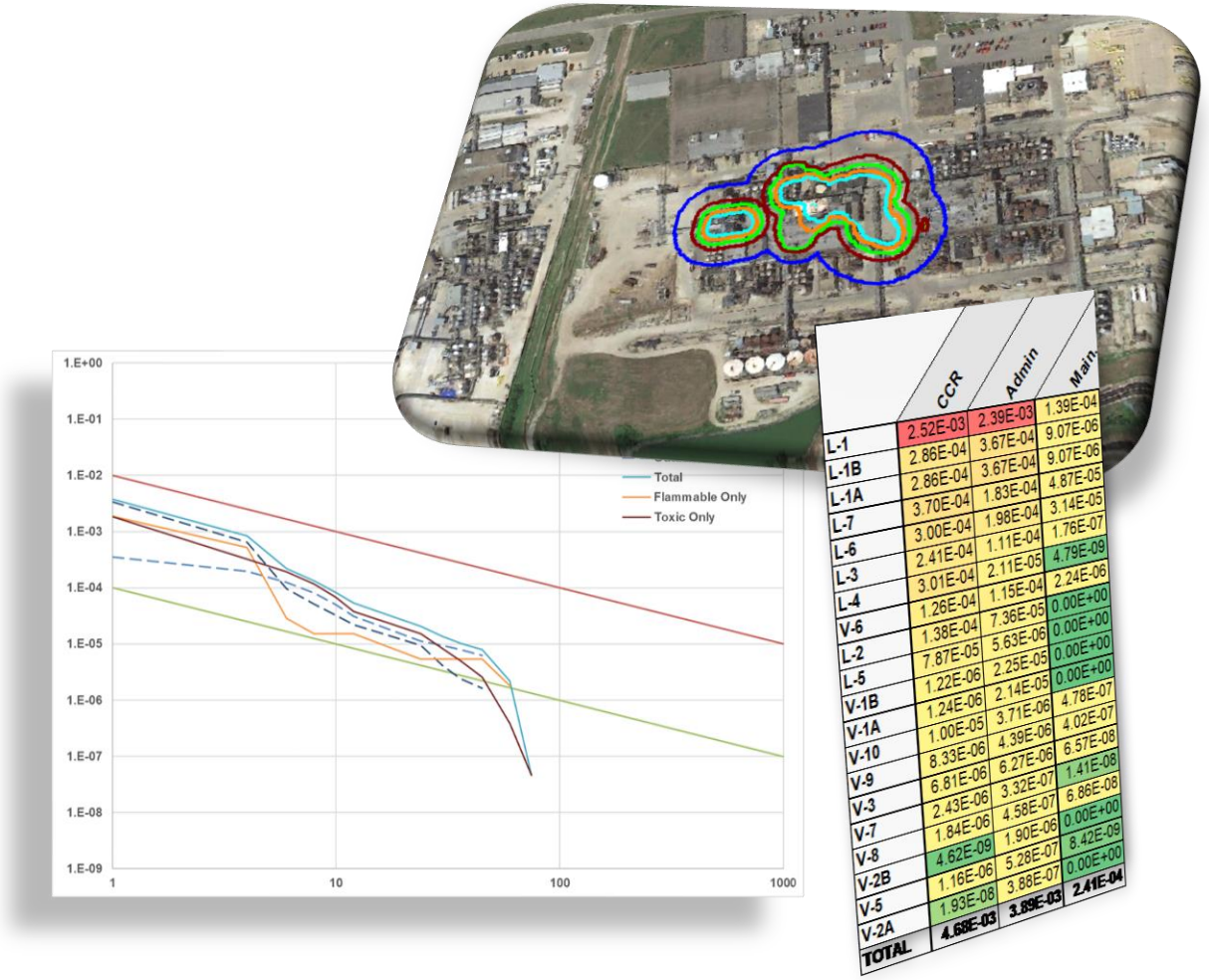
Process Hazard Analysis

- Accepted framework
- Applied for decades
- PHA tools remain the same
  - Team-based approach to risk analysis
- Organizational comfort
- Vetted and accepted risk matrix
- Acceptable safeguards



Risk-Based Siting

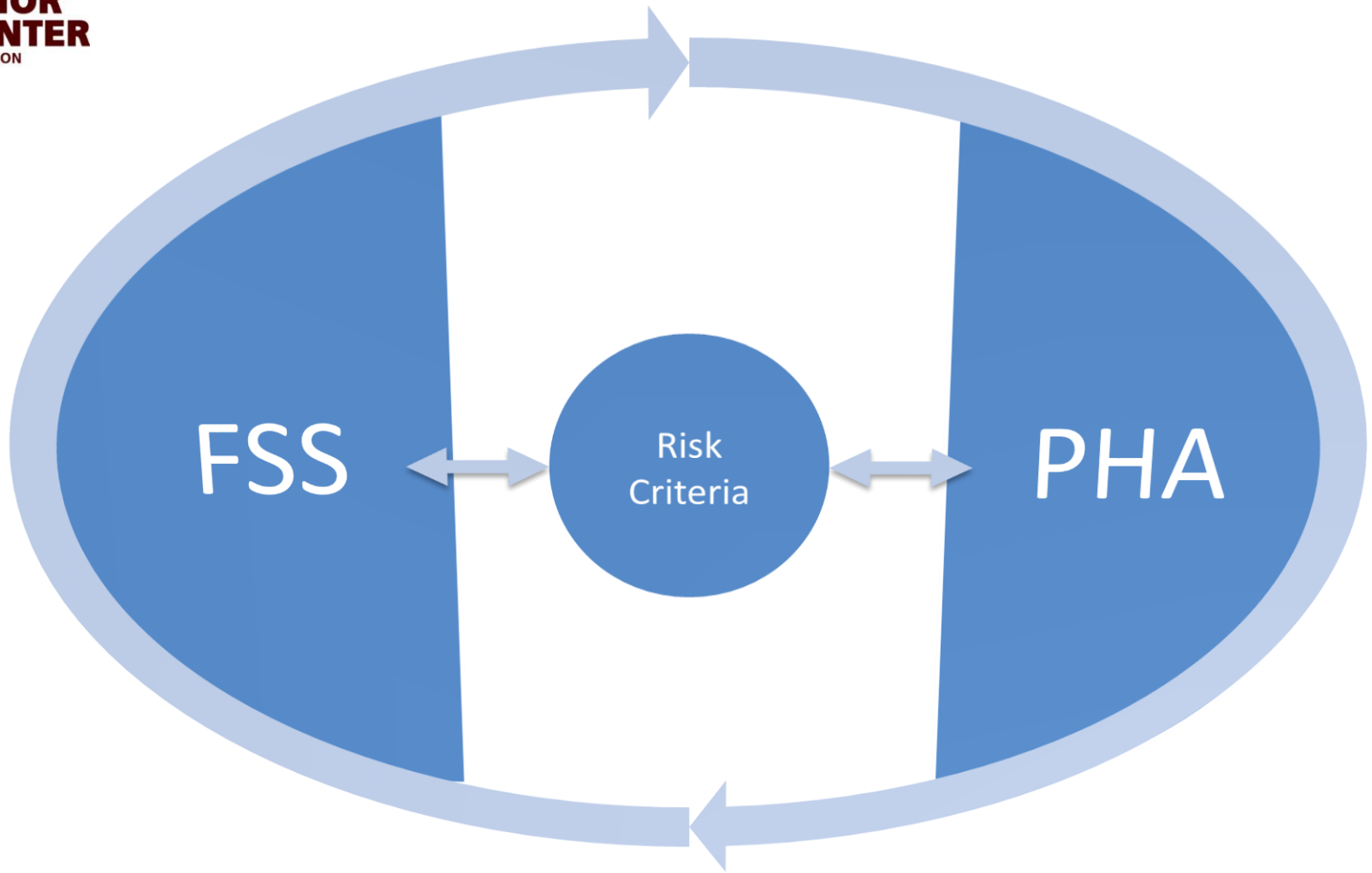
- Stakeholder have less familiarity
- Risk
  - Individual
  - Societal
  - Location-Specific
  - Building-Specific
  - Worker-Specific
- Risk measures are less straightforward
  - Do not reference the familiar risk matrix
- Often not linked directly to a single incident
  - Aggregate risk



	CCR	Admin	Main
L-1	2.52E-03	2.39E-03	1.39E-04
L-1B	2.86E-04	3.67E-04	9.07E-06
L-1A	2.86E-04	3.67E-04	9.07E-06
L-7	3.70E-04	1.83E-04	4.87E-05
L-6	3.00E-04	1.98E-04	3.14E-05
L-3	2.41E-04	1.11E-04	1.76E-07
L-4	3.01E-04	2.11E-05	4.79E-09
V-6	1.26E-04	1.15E-04	2.24E-06
L-2	1.38E-04	7.36E-05	0.00E+00
L-5	7.87E-05	5.63E-06	0.00E+00
V-1B	1.22E-06	2.25E-05	0.00E+00
V-1A	1.24E-06	2.14E-05	0.00E+00
V-10	1.00E-05	3.71E-06	4.78E-07
V-9	8.33E-06	4.39E-06	4.02E-07
V-3	6.81E-06	6.27E-06	6.57E-08
V-7	2.43E-06	3.32E-07	1.41E-08
V-8	1.84E-06	4.58E-07	6.86E-08
V-2B	4.62E-09	1.90E-06	0.00E+00
V-5	1.16E-06	5.28E-07	8.42E-09
V-2A	1.93E-08	3.88E-07	0.00E+00
TOTAL	4.68E-03	3.89E-03	2.41E-04

How do we make the studies work together?

Let’s look first at what each one contains



Elements of Hazard Analysis Studies

PHA

- Looks at risk from a process viewpoint
- Recommendations based on qualitative risk assessment – team ‘gut feeling’

Facility Siting

- Looks at risk/hazards from a building viewpoint
- Recommendations based on quantitative risk assessment – what is the actual risk

How PHA Feeds to FSS

PHA

- Key PHA Elements
  - Cause
  - Consequence
  - Safeguards
  - Risk ranking

Unique Process Hazard Scenarios

Detection/ Isolation;
Secondary Containment;
Emergency Blowdown;
Ventilation;
Water Deluge

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Aligning Scenarios

Aligning the PHA scenarios with the siting study can improve the quality of the siting study

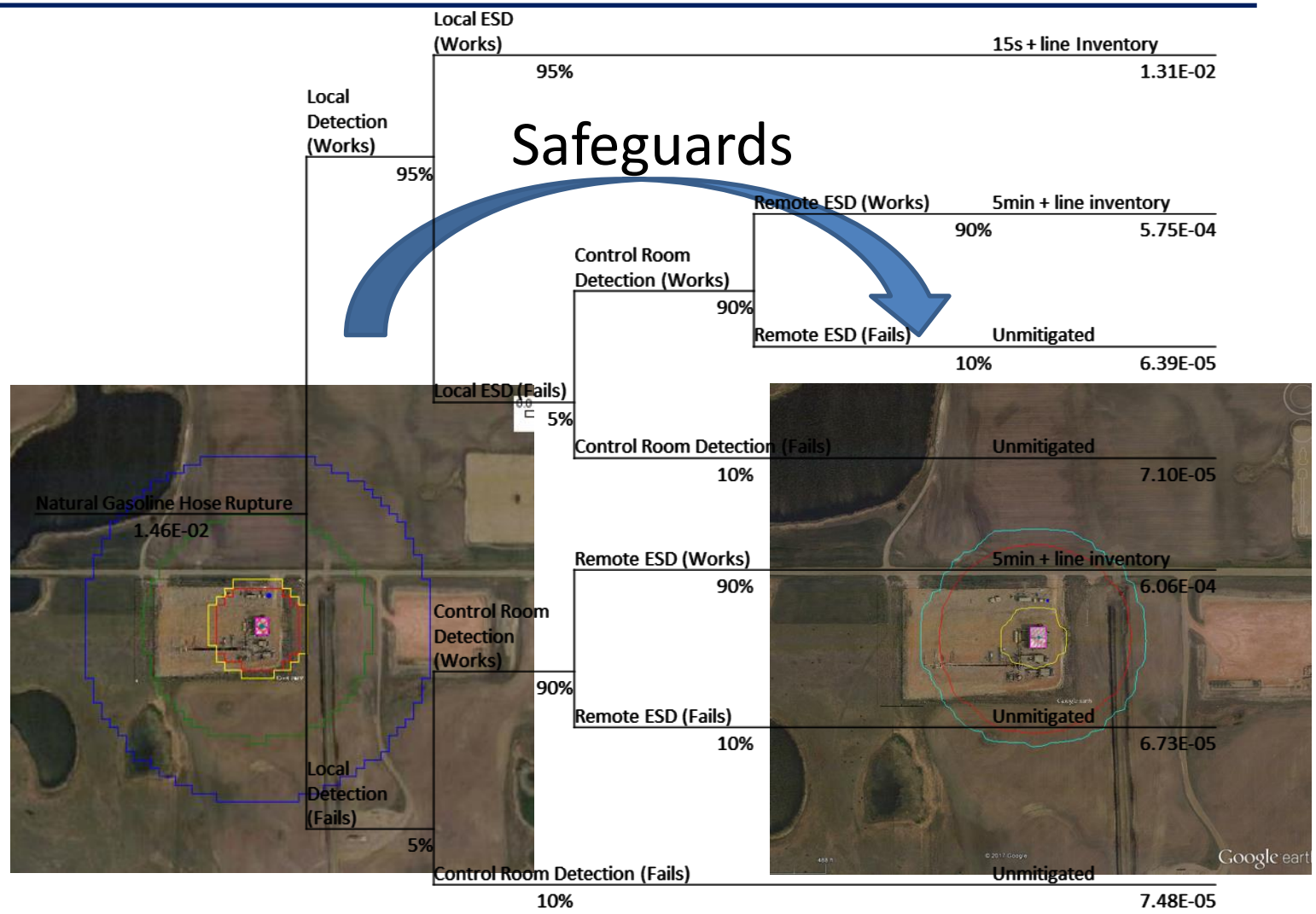
The PHA should be considered during the siting study HAZID

Generic release scenarios are generally included in a siting study but process-specific hazard scenarios from the PHA should also be considered.

The siting study may provide a more complete and accurate risk assessment of the PHA scenario

Safeguard

- Safeguards
  - PHA safeguards should be considered to define frequencies for scenario-based hazards in the FSS
  - FSS can assess the efficacy (consequence impacts) of certain safeguards (detection/isolation)
  - FSS may utilize event trees to consider the likelihood of mitigation options; may inform PHA safeguard listing



How FSS Feeds to PHA

Facility Siting

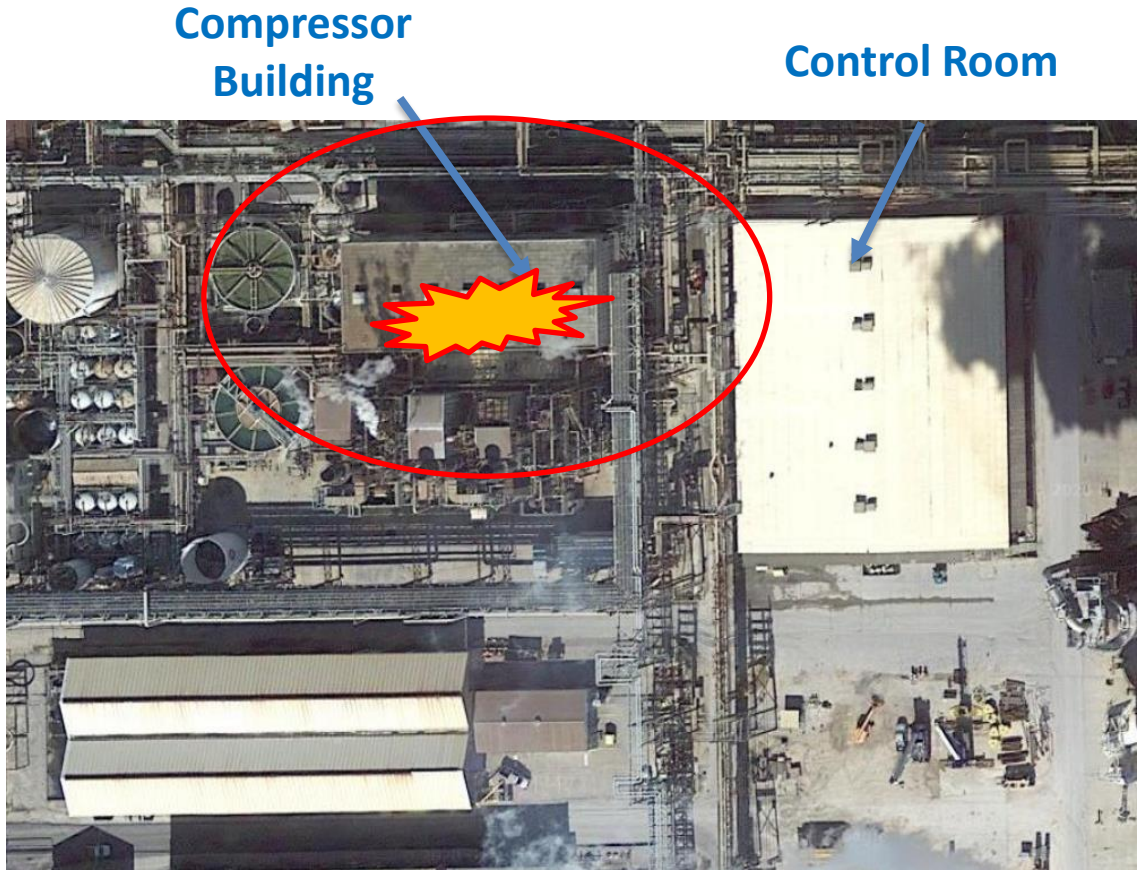
- Key FSS Elements
  - Consequence Modeling
    - Release Scenarios
    - Hazard Identification
    - Location/ Climate
  - Vulnerability Criteria
    - Building Design Information
  - Frequency Analysis
    - Likelihood of release, weather, ignition

Single Scenario Consequence (consequence severity)

Single Scenario Risk (severity/ likelihood of a single scenario)

Individual Risk (risk of all release scenarios on one person in a building)

Consequence



- Consequence
  - Consequence modeling can identify the maximum extent of the hazard for PHAs
  - Quantitative FSS results should be referenced when the PHA is revalidated to create more accurate qualitative consequence evaluation
  - FSS scenario modeling can be used as reference point for PHA

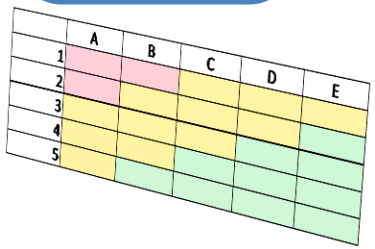
Information Flow Between Studies

PHA

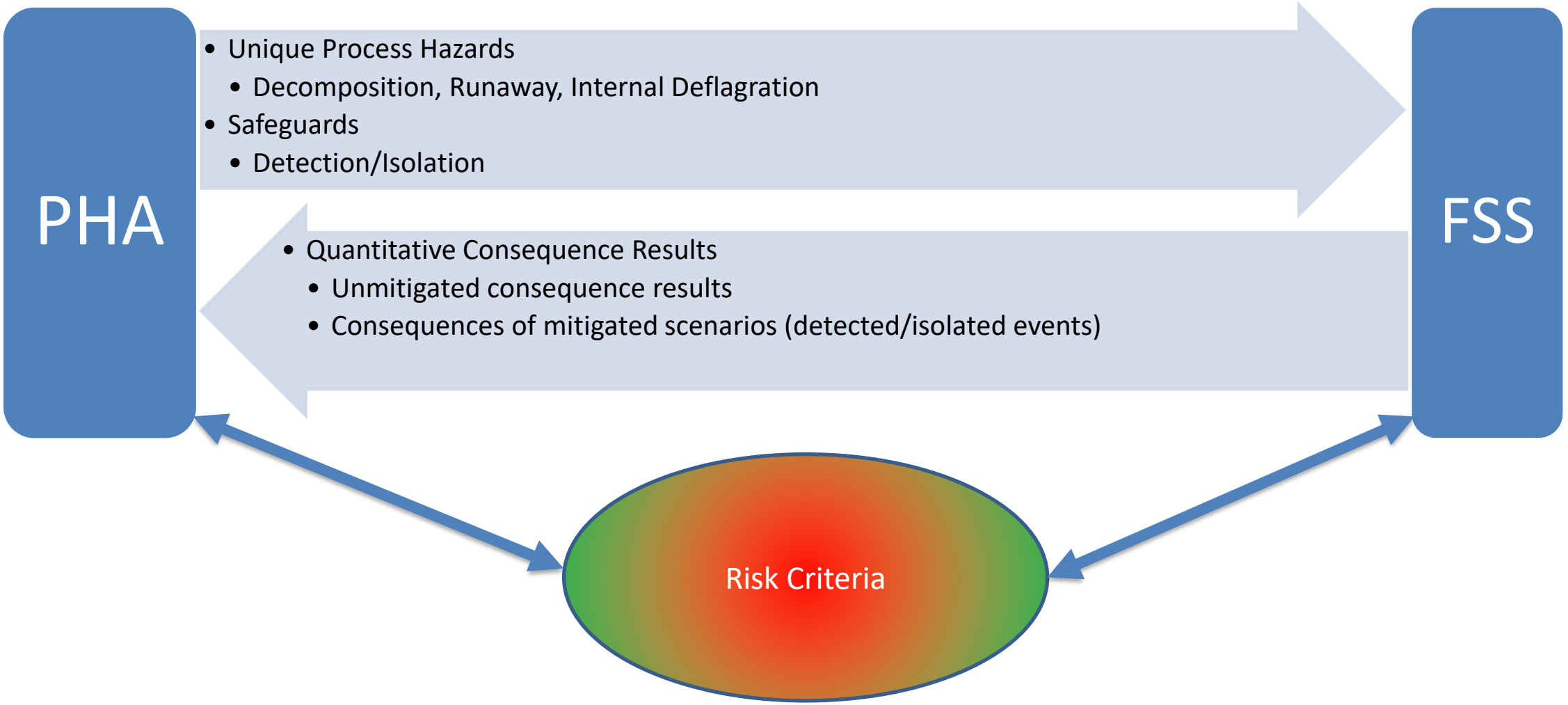
- Unique Process Hazards
  - Decomposition, Runaway, Internal Deflagration
- Safeguards
  - Detection/Isolation

- Quantitative Consequence Results
  - Unmitigated consequence results
  - Consequences of mitigated scenarios (detected/isolated events)

FSS

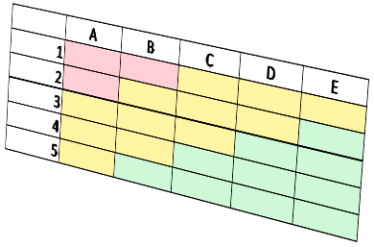


Information Flow Between Studies



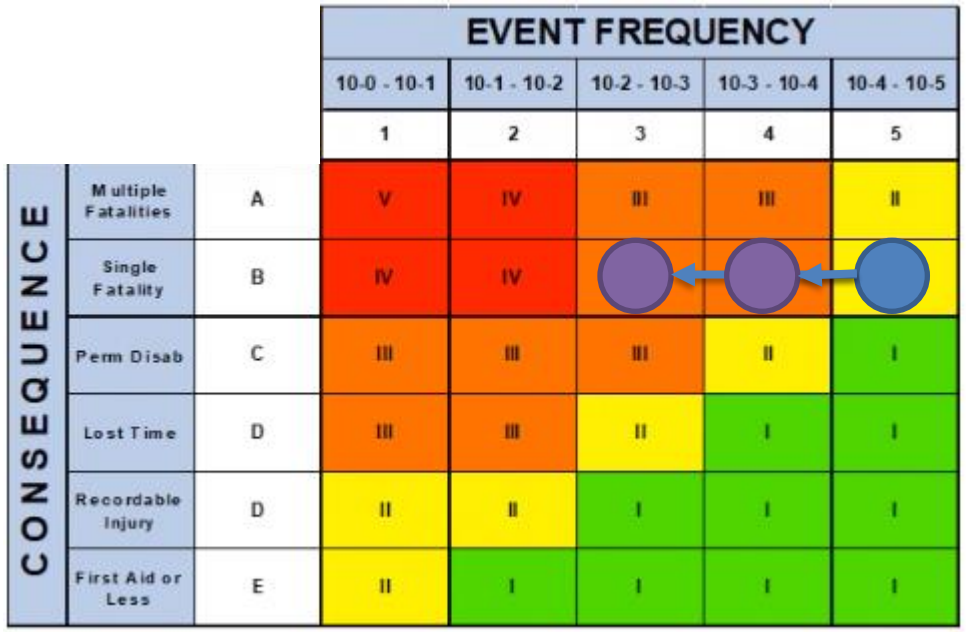
Risk Criteria

- PHAs assess risk for each scenario that is considered in the study
- The team estimates the severity of each scenario
- The team estimates or calculates the frequency of each scenario
- Risk assessments are for individual scenarios



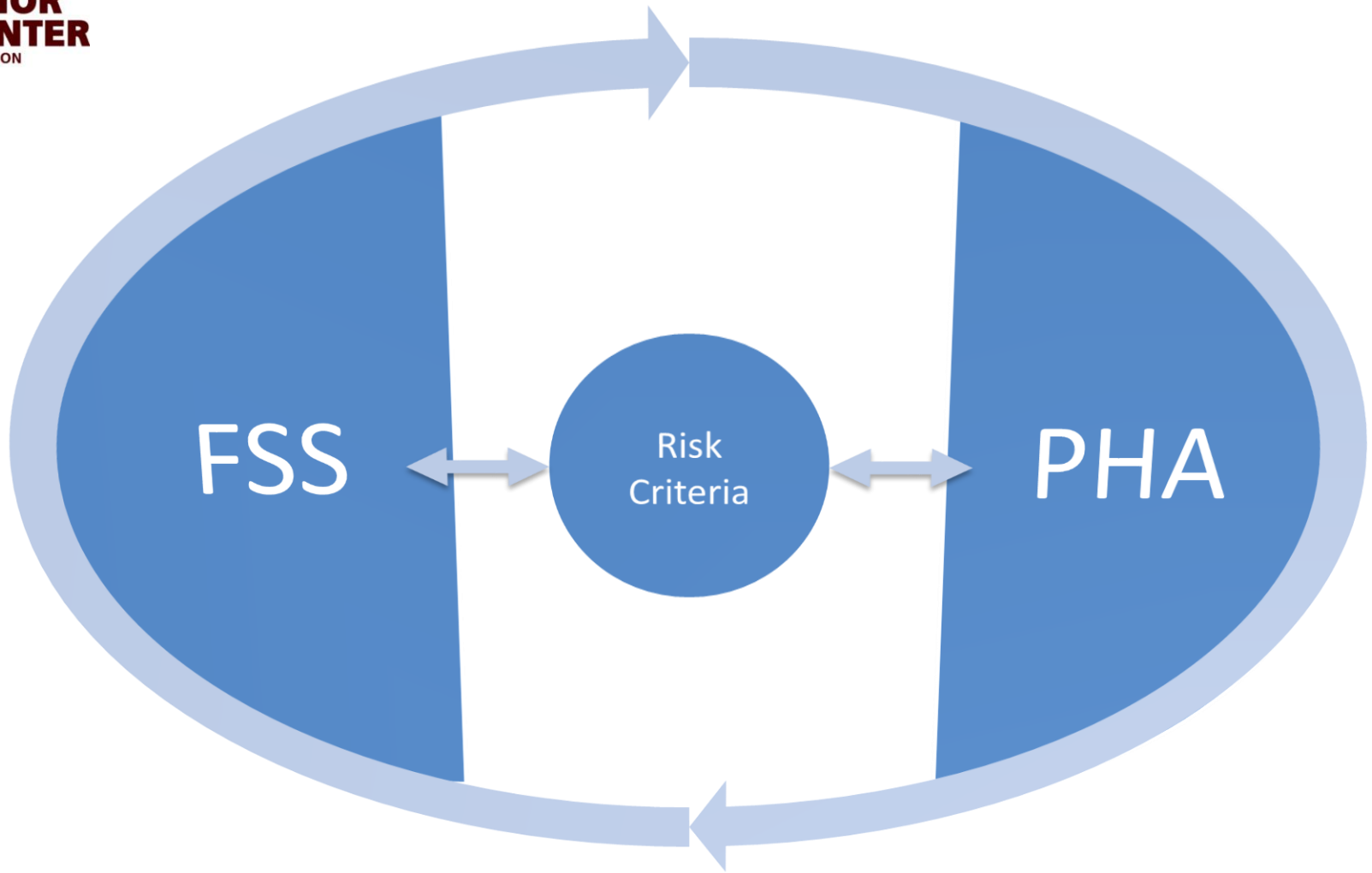
- FSSs assess risk to building occupants from all scenarios in the study
- The study models the severity of each scenario (impacts to all buildings)
- The study calculates the frequency of each scenario
- The risk is then aggregated/summed for each building to determine the cumulative risk at each location or for the site overall

Risk Criteria



CONSEQUENCE			EVENT FREQUENCY				
			10-0 - 10-1	10-1 - 10-2	10-2 - 10-3	10-3 - 10-4	10-4 - 10-5
			1	2	3	4	5
	Multiple Fatalities	A	V	IV	III	III	II
	Single Fatality	B	IV	IV			
	Perm Disab	C	III	III	III	II	I
	Lost Time	D	III	III	II	I	I
	Recordable Injury	D	II	II	I	I	I
	First Aid or Less	E	II	I	I	I	I

- Risk Criteria
  - The acceptable frequency for aggregate risk criteria must inevitably be greater than that used in PHAs
    - Aggregate risk is the SUM of all process hazard scenario risks with the potential to impact a location
    - Expect aggregate risk criteria to be 10-100x higher than the PHA risk criteria
      - Dependent on the number of hazards which could impact a location
    - F-N pairs could be compared directly to a risk matrix



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Questions?

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